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⑰ **High-voltage variable resistor.**

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Description

The present invention relates to a high voltage resistor comprising a platelike substrate provided with a resistor portion having at least one circular portion with said resistor portion being formed on one of the major surfaces of said substrate by printing, a sliding member provided so as to confront said one of said major surfaces of said substrate and to be rotated in sliding contact with said circular portion of said resistor portion of said substrate, a plurality of connecting terminals connected to said resistor portion and said sliding member so as to rotate said sliding member, and a casing for accommodating said substrate and said sliding member therein, with a part of said rotational rod projecting out of said casing.

A resistor of this general kind is known from JP—U—5468144.

From the document US—A—3531755 is known the use of spring contacts to a wire-wound resistor in order to contact accurately the termination points of the resistance element.

Conventionally flyback transformers for use with the high voltage variable resistor of the invention have been especially designed to suppress the voltage regulation and to minimize variations in the width of pictures on a screen of a television set, such voltage regulation may alternatively be restricted to a small value by causing a large current to flow through the high-voltage variable resistor for supplying focussing voltage and screen voltage to the cathode-ray tube of the television set.

A table 1 below shows one example of relations of total resistance R_T of the high-voltage variable resistor connected to the flyback transformer, variations in width of pictures on the screen, and voltage regulation of the flyback transformer.

TABLE 1

Total resistance R_T (M Ω)	100	75	67	50
Variations in width of pictures on screen (mm)	8	6	5	3
Voltage regulation (KV)	3.75	3.60	3.55	3.35

It is to be noted that voltage applied to the high-voltage variable resistor in Table 1 is approximately 13.5 KV. It is easily understood from Table 1 that characteristics of the flyback transformer can be remarkably improved by reducing the total resistance R_T . Meanwhile, reduction in the total resistance R_T will increase load for the high-voltage variable resistor, thus raising temperature of the high-voltage variable resistor by Joule's heat.

From JP—U—54/68 144 a high voltage variable resistor is known. This known resistor is arranged as shown in Figs. 1(a) to 1(d) that connecting terminal pins 3a for receiving a high voltage supplied from a flyback transformer, 3b for supplying a focussing voltage, 3c for supplying a screen voltage, and 3d for grounding or earthing are soldered to an insulating substrate 1 at right angles thereto. More specifically, the plate-like rectangular insulating substrate 1 is made of sintered alumina or ceramics, etc. and has a front face 1A and a rear face 1B. It should be noted here that all directional indications such as "front", "rear", "upper", "lower", etc. are based on the illustration in Figs. 1(c) and 1(d), hereinbelow. On the front face 1A of the insulating substrate 1, a resistor portion or layer 1c of a curved shape, a first electrically conductive portion 1e of a bent shape and a second electrically conductive portion 1g of a linear shape are printed and baked. The resistor portion 1c is formed so as to extend downwardly in a zigzag manner along a left side edge on the front face 1A of the substrate 1 and includes an electrode 1h for the connecting terminal pin 3a, provided at an upper end thereof, a first circular portion 1a, a second circular portion 1b, and an electrode 1i for the connecting terminal 3d, provided at a lower end thereof. The first electrically conductive portion 1e is formed so as to extend downwardly generally in a V-shape on an upper right portion of the front face 1A and includes an electrode 1j for the connecting terminal pin 3b, provided at an upper end thereof and a first central portion 1d which is provided at a lower end thereof so as to be disposed at the center of the first circular portion 1a of the resistor portion 1c. The second electrical conductive portion 1g is formed so as to extend laterally on a lower right portion of the front face 1A and includes an electrode 1k for the connecting terminal pin 3c, provided at a right end thereof and a second central portion 1f which is provided at a left end thereof so as to be disposed at the center of the second circular portion 1b of the resistor portion 1c. Thus, the electrodes 1h, 1i, 1j and 1k are formed at four corner portions of the front face 1A so as to be disposed in a symmetric relation with respect to corresponding four corners of the front face 1A. Since the first circular portion 1a is disposed above the second circular portion 1b, the first central portion 1d and second central portion 1f are provided approximately at the center in the lateral direction of the front face 1A with the first central portion 1d being disposed above the second central portion 1f. The electrodes 1h, 1i, 1j and 1k are formed with through-openings 1h', 1i', 1j' and 1k', respectively. Through-holes 1l and 1m are formed on the front face 1A so as to be, respectively, disposed above the first circular portion 1a, and between the first circular portion 1a and the second circular portion 1b. The electrodes 1h, 1i, 1j and 1k, first central portion 1d and second central portion 1f are provided with electrically conductive paste mainly consisting of silver.

The insulating casing 6 is made of synthetic resin and is formed into a rectangular shape. The insulating casing 6 includes a front wall 6H, an upper side wall 6D, a lower side wall 6E, a left side wall 6F and a right side wall 6G with the rear face 6B being not formed with a wall, a rectangular accommodation recess for accommodating the insulating substrate 1 therein, which is enclosed by the front wall 6H, upper side wall 6D, lower side wall 6E, left side wall 6F and right side wall 6G is provided in the insulating casing 6. An upper cylindrical boss 6I and a lower cylindrical boss 6J each provided with a through-hole are integrally formed with the insulating casing 6 on the front face 6A and at the center in the lateral direction of the insulating casing 6. Further, an upper cylindrical projection 6a and a lower cylindrical projection (not shown) each extending over a slight distance from one face of the front wall 6H opposite to the front face 6A in a direction remote from the front face 1A are integrally formed with the insulating casing 6 and are, respectively, disposed at the center in the lateral direction of the insulating casing 6 above the through-hole of the upper cylindrical boss 6I and between the through-hole of the upper cylindrical boss 6I and the through-hole of the lower cylindrical boss 6J. The upper side wall 6D includes a front wall portion 6Da and a rear wall portion 6Db with the front wall portion 6Da being slightly larger, in thickness, than the rear wall portion 6Db. Likewise, the lower side wall 6E, left side wall 6F and right side wall 6G include front wall portions and rear wall portions, respectively, so that a rectangular bearing face 6C for supporting the insulating substrate 1 is formed on side edges of the front wall portion 6Da and the front wall portions of the lower side wall 6E, left side wall 6F and right side wall 6G at the joint with the rear wall portion 6Db, and the rear wall portions of the lower side wall 6E, left side wall 6F and right side wall 6G, respectively.

The conventional high-voltage variable resistors are further provided with an adjusting rod 4 for adjusting the focussing voltage through manual rotation thereof and an adjusting rod 5 for adjusting the screen voltage through manual rotation thereof. The adjusting rod 4 has a knurled portion 4a formed at one end thereof for facilitating the rotation and a flange portion 4b formed at the other end thereof. Similarly, the adjusting rod 5 has a knurled portion 5a and a flange portion (not shown). An elongated first sliding member 2a having one end 2a1 and the other end 2a2 is fixedly attached to one face of the flange portion 4b remote from the knurled portion 4a with the other end 2a2 being disposed concentrically with the axis of the adjusting rod 4. In the same manner as described above, an elongated second sliding member (not shown) having one end and the other end is fixedly attached to one face of the flange portion of the adjusting rod 5 remote from the knurled portion 5a with the other end of the second sliding member being disposed concentrically with the axis of the adjusting rod 5. The connecting terminal pins 3a for receiving the high voltage supplied from the flyback transformer, 3b for supplying the focussing voltage, 3c for supplying the screen voltage, and 3d for earthing are, respectively, fitted into the through-openings 1h', 1j', 1k' and 1i' of the insulating substrate 1 so as to extend therethrough and then, are soldered to the insulating substrate 1 on the front face 1A. Accordingly, deposited solder portions 9 are formed at the through-openings 1h', 1i', ij, and 1k' on the front face 1A. It should be noted that flux deposited on the insulating substrate 1 during the soldering causes deterioration in electrical insulation of the insulating substrate 1 and therefore, is removed from the insulating substrate 1 by washing. When the adjusting rod 4 for adjusting the focussing voltage and the adjusting rod 5 for adjusting the screen voltage are, respectively, fitted into the through-hole of the upper cylindrical boss 6I and the through-hole of the lower cylindrical boss 6J in a direction from the rear face 6B to the front face 6A so that the other face of the flange portion 4b adjacent to the knurled portion 4a and the other face of the flange portion of the adjusting rod 5 adjacent to the knurled portion 5a may be brought into contact with the one face of the front wall 6H remote from the front face 6A with the sliding members 2a and 2b being, respectively, secured to the flange portion 4b of the adjusting rod 4 and the flange portion of the adjusting rod 5, the knurled portions 4a and 4b project out of the upper cylindrical boss 6I and lower cylindrical boss 6J, respectively. Then, the insulating substrate 1 having the connecting terminal pins 3a, 3b, 3c and 3d soldered thereto are fitted into the accommodation recess of the insulating casing 6 so as to be positioned through fitting of the upper cylindrical projection 6a and lower cylindrical projection 6b into the respective through-holes 1l and 1m so that a part of each of the upper cylindrical projection 6a and lower cylindrical projection 6b may project out of the rear face 1B of the insulating substrate 1. The insulating substrate 1 is fixedly attached to the insulating casing 6 by securing the part of each of the upper cylindrical projection 6a and lower cylindrical projection 6b projecting out of the rear face 1B, through melting thereof, to the rear face 1B with peripheral portions of the front face 1A of the insulating substrate 1 being in contact with the bearing face 6C of the insulating casing 6, whereby the connecting terminal pins 3a, 3b, 3c and 3d project out of the rear face 6B of the insulating casing 6 at right angles to the insulating substrate 1 so as to be electrically connected to the flyback transformer.

Furthermore, since a relatively high voltage is applied to the connecting terminal pins 3a, 3b and 3c, the connecting terminal pins 3a, 3b and 3c are, respectively, partially protected by cylindrical insulating covers 7a, 7b and 7c. It is to be noted that, since a voltage applied to the connecting terminal pin 3d for earthing is relatively low, the connecting terminal pin 3d is not required to be protected by an insulating cover.

Subsequently, thermosetting resin 8 such as epoxy resin, etc. is applied to the whole surface of the rear face 1B of the insulating substrate 1 up to the rear face 6B of the insulating casing 6 for the purpose of electrically insulating the insulating substrate 1, absorbing an impact to be applied to the connecting terminal pins 3a, 3b, 3c and 3d and fixing the insulating covers 7a, 7b and 7c in position. Accordingly, thickness of the thermosetting resin 8 is required to be sufficiently large therefor.

In the above described arrangement of the prior art high-voltage variable resistor, the one end 2a1 of the first sliding member 2a fixedly attached to the flange portion 4b of the adjusting rod 4 is caused to make a circular motion along and in sliding contact with the first circular portion 1a of the resistor portion 1c upon manual rotation of the adjusting rod 4 with the other end 2a2 being in contact with the first central portion 1d of the first electrically conductive portion 1e. Likewise, the one end of the second sliding member fixedly attached to the flange portion of the adjusting rod 5 is caused to make a circular motion along and in sliding contact with the second circular portion 1b upon manual rotation of the adjusting rod 5 with the other end of the second sliding member being in contact with the second central portion 1f of the second electrically conductive portion 1g. Accordingly, a high voltage supplied from the flyback transformer to the connecting terminal pin 3a is lowered by a part of the resistor portion 1c extending from the electrode 1h to the first circular portion 1a and then, is varied upon manual rotation of the adjusting rod 4 so as to supply the focussing voltage from the connecting terminal pin 3b owing to electrical contact of the first circular portion 1a of the resistor portion 1c by the first central portion 1d of the first electrically conductive portion 1e through the first sliding member 2a.

The focussing voltage is further lowered by another part of the resistor portion 1c extending from the first circular portion 1a to the second circular portion 1b and then, is varied upon manual rotation of the adjusting rod 5 so as to supply the screen voltage from the connecting terminal pin 3c owing to electrical contact of the second circular portion 1b of the resistor portion 1c by the second central portion 1f of the second electrically conductive portion 1g through the second sliding member.

However, the known high-voltage variable resistors have such a disadvantage that, when the connecting terminal pins 3a, 3b, 3c and 3d are subjected to a large bending moment, the deposited solder portions 9 tend to be separated from the insulating substrate 1, resulting in faulty electrical conduction between the connecting terminal pins 3a, 3b, 3c and 3d and the insulating substrate 1. Meanwhile, even if it is so arranged that a force applied to the connecting terminal pins 3a, 3b, 3c and 3d is absorbed by the thermosetting resin 8, it becomes necessary to inject a greater amount of the thermosetting resin 8 than required for electrical insulation.

Furthermore, the prior art high-voltage variable resistors have such an inconvenience that, if flux used for soldering of the connecting terminal pins 3a, 3b, 3c and 3d to the insulating substrate 1 is not completely removed from the insulating substrate 1 by a washing process and remains on the insulating substrate 1, creeping discharge undesirably takes place on the front face 1A of the insulating substrate 1.

Moreover, the conventional high-voltage variable resistors have been disadvantageous in that, unless a strict control over materials of the solder is exercised, an undesirable phenomenon that dewetting of the solder is caused through diffusion, in the solder, of silver contained in the electrically conductive paste takes place at the electrodes 1h, 1i, 1j and 1k provided with the electrically conductive paste, thus resulting in faulty soldering.

The conventional high-voltage variable resistors have such an disadvantage that, since the insulating casing 6 or the insulating covers 7a, 7b and 7c are deformed by heating of the thermosetting resin 8 for curing thereof, the connecting terminal pins 3a, 3b, 3c and 3d are not positively held by the insulating casing 6, thereby causing displacement of the connecting terminal pins 3a, 3b, 3c and 3d.

Furthermore, although thickness of the thermosetting resin 8 is required to be sufficiently large as described above, the thermosetting resin 8 has a low thermal conductivity of approximate 10^{-3} cal/cm · sec · °C, so that heat produced at the resistor portion 1c is not emitted out of the insulating casing 6 if the thickness of the thermosetting resin 8 is guide large and thus, temperature in the insulating casing 6 rises considerably, thereby resulting in deterioration of elasticity of the thermosetting resin 8 and sliding members 2a and 2b or degradation of the resistor portion 1c. Accordingly, the known high-voltage variable resistors have such an inconvenience that since load applied to one unit area of the insulating substrate 1 is restricted to some value, the insulating substrate 1 is required to have a large area if a high-voltage variable resistor for large electric currents is to be produced.

Accordingly, an essential object of the present invention is to provide an improved high-voltage variable resistor which eliminates the need for a soldering process and a flux washing process, with substantial elimination of disadvantages inherent in conventional high-voltage resistors of this kind.

This object according to the invention is solved by the features that said connecting terminal 3a—d are disposed in parallel with said major surfaces 1'A of said substrate, each of said connecting terminals 3a—d having a contact portion extending in parallel with said major surfaces of the substrate, that a plurality of space portions 11A, each surrounded by an insulating wall, are formed in said casing, that spring means 10 are, respectively, accommodated in said space portions 11Aa, 11Ab and that an urging force of said spring means 10 is directed at right angles to said major surfaces of said substrate 1, and that said connecting terminals 3a—d extend, respectively, through said casing 6 into said space portions 11Aa, 11Ab such that each of said connector portions 1h—k of said resistor portion and each of said contact portions of said connecting terminals 3a—d are connected to each other in each of said space portions 11Aa, 11Ab by each of said spring means 10.

In accordance with the present invention, since the connecting terminal pins are disposed in parallel with the major surfaces of the insulating substrate and the connecting terminal pins are electrically connected to the insulating substrate through the springs, it becomes unnecessary to perform the soldering process and the flux washing process.

Furthermore, in accordance with the present invention, even if a large external force is applied to the connecting terminal pins, damage to the insulating substrate and improper contact between the insulating substrate and the connecting terminal pins are desirably eliminated, whereby working efficiency and reliability of the high-voltage variable resistor have been remarkably improved.

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Brief description of the drawings

These and other objects and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings, in which:

- 10 Fig. 1(a) is a perspective view of a conventional high-voltage variable resistor,
 Fig. 1(b) is a side elevational view, partly in section, of the high-voltage variable resistor of Fig. 1(a),
 Fig. 1(c) is a front elevation view of an insulating substrate employed in the high-voltage variable resistor of Fig. 1(a),
 Fig. 1(d) is a front elevational view of the high-voltage variable resistor of Fig. 1(a),
 15 Fig. 2(a) is a view similar to Fig. 1(a), showing a high-voltage variable resistor according to a first embodiment of the present invention,
 Fig. 2(b) is a view similar to Fig. 1(b), showing the high-voltage variable resistor of Fig. 2(a),
 Fig. 2(c) is a view similar to Fig. 1(c), showing an insulating substrate employed in the high-voltage variable resistor of Fig. 2(a),
 20 Fig. 3 is a fragmentary perspective view of the high-voltage variable resistor of Fig. 2(a) with the insulating substrate being removed therefrom,
 Figs. 4(a), 4(b) and 4(c) are views showing on an enlarged scale springs of various configurations employed in the high-voltage variable resistor of Figs. 2(a),
 Fig. 5(a) is a view similar to Fig. 2(b), showing on an enlarged scale a high-voltage variable resistor
 25 according to a second embodiment of the present invention,
 Fig. 5(b) is a view explanatory of assembly of the high-voltage variable resistor of Fig. 5(a),
 Figs. 5(c) and 5(d) are views similar to Fig. 4(a), showing springs of various configurations employed in the high-voltage variable resistor of Fig. 5(a),
 Figs. 6(a) and 6(b) are views showing on an enlarged scale connecting terminal pins employed in the
 30 high-voltage variable resistor of Fig. 5(a),
 Fig. 7 is a perspective view of a high-voltage variable resistor according to a third embodiment of the present invention with its insulating substrate being removed therefrom,
 Fig. 8 is a view similar to Fig. 2(b), showing on an enlarged scale the high-voltage variable resistor of Fig. 7,
 35 Fig. 9 is a view similar to Fig. 2(b), showing on an enlarged scale a high-voltage variable resistor according to a fourth embodiment of the present invention,
 Fig. 10 is a rear elevational view of the high-voltage variable resistor of Fig. 9,
 Fig. 11 is a view explanatory of injection of thermosetting resin in the high-voltage variable resistor of Fig. 9, and
 40 Figs. 12 and 13 are views showing on an enlarged scale insulating casings of various configurations employed in the high-voltage variable resistor of Fig. 9.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout several views of the accompanying drawings.

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Detailed description of the invention

Referring now to the drawings, there is shown in Figs. 2(a) to 2(c), 3 and 4(a) to 4(c), a high voltage variable resistor K according to a first embodiment of the present invention.

- 50 The high voltage variable resistor K includes an insulating substrate 1' having a front face 1'A and a rear face 1'B, an insulating casing 6' having a front face 6'A and a rear face 6'B, and an electrically conductive coiled spring 10. It is to be noted that the insulating substrate 1' is equal, in the arrangements, to the insulating substrate 1 except that the electrodes 1h, 1i, 1j and 1k of the insulating substrate 1' are not, respectively, formed with the through-openings 1h', 1i', 1j' and 1k' of the conventional high-voltage variable resistor as shown in Fig. 2(c).

- 55 The insulating casing 6' includes a front wall 6'H, an upper side wall 6'D, a lower side wall 6'E, a left side wall 6'F and a right side wall 6'G. The upper side wall 6'D includes a front wall portion 6'Da and a rear wall portion 6'Db which is smaller, in thickness, than the front wall portion 6'Da. Likewise, the lower side wall 6'E, left side wall 6'F and right side wall 6'G includes front wall portions and rear wall portions, respectively, so that a rectangular bearing face 6'C for supporting the insulating substrate 1' is formed on
 60 side edges of the front wall portion 6'Da, and the front wall portions of the lower side wall 6'E, left side wall 6'F and right side wall 6'G at the joint with the rear wall portion 6'Db, and the rear wall portions of the lower side wall 6'E, left side wall 6'F and right side wall 6'G, respectively.

- The insulating casing 6' has a through-openings (not shown) and a through-opening 11b formed, respectively, adjacent to the left side wall 6'F and right side wall 6'G on the front wall portion 6'Da of the
 65 upper side wall 6'D. Likewise, the insulating casing 6' further has through-openings (not shown) formed,

respectively, adjacent to the right side wall 6'G and left side wall 6'F on the front wall portion of the lower side wall 6'E.

Annular insulating covers 7'a and 7'b are integrally formed with the insulating casing 6' in concentricity with the through-opening formed adjacent to the left side wall 6'F on the front wall portion 6'Da and the through-opening 11b, respectively, so as to project out of the upper side wall 6'D in parallel with the front face 6'A. Likewise, an annular insulating cover 7'c is integrally formed with the insulating casing 6' in concentricity with the through-opening formed adjacent to the right side wall 6'G on the front wall portion of the lower side wall 6'E so as to project out of the lower side wall 6'E in parallel with the front face 6'A.

Furthermore, as shown in Figs. 2(b) and 3, L-shaped walls are provided at the four corners of the front wall 6'H on one face of the front face 6'H opposite to the front face 6'A so as to form rectangular space portions 11Aa and 11Ab, and two other rectangular space portions formed, respectively, at the lower right and lower left corners of the front wall 6'H on the one face of the front wall 6'H opposite to the front face 6'A which are communicated with the through-opening extending concentrically with the insulating cover 7'a, through-opening 11b, through-opening extending concentrically with the insulating cover 7'c and through-opening formed adjacent to the left side wall 6'F on the front wall portion of the lower side wall 6'E, respectively. The L-shaped walls are formed slightly smaller, in height, than the front wall portion 6'Da, and the front wall portions of the lower side wall 6'E, left side wall 6'F and right side wall 6'G.

The left side wall 6'F and right side wall 6'G have, respectively, guide rails 12 and 13 which are formed adjacent to the rear face 6'B so as to extend from the upper side wall 6'D to the lower side wall 6'E. The guide rails 12 and 13 have, respectively, lugs 12a and 13a formed adjacent to the lower side wall 6'E.

It is to be noted that a flyback transformer for use with the high-voltage variable resistor K has guide grooves corresponding to the guide rails 12 and 13 and the guide grooves further have engagement recesses for engagement with the lugs 12a and 13a, respectively. It is so arranged that, when the high-voltage variable resistor K is mounted on the flyback transformer, the guide rails 12 and 13 are, respectively, fitted downwardly into the guide grooves of the flyback transformer so that the high-voltage variable resistor K may be securely held by the flyback transformer through engagement of the lugs 12a and 13a by the respective engagement recesses.

In the above described arrangements of the high-voltage variable resistor K, the connecting terminal pins 3a, 3b, 3c and 3d are, respectively, fitted, in parallel with the insulating substrate 1', into the through-opening extending concentrically with the insulating cover 7'a, through-opening 11b, through-opening extending concentrically with the insulating cover 7'c and through-opening formed adjacent to the left side wall 6'F on the front wall portion of the lower side wall 6'E so as to extend into the space portions 11Aa and 11Ab, and the space portions formed, respectively, at the lower right and lower left corners of the front wall 6'H on the one face of the front wall 6'H opposite to the front face 6'A. The electrically conductive coiled springs 10 are, respectively, provided in pressing contact with the electrode 1h and the connecting terminal pin 3a in the space portion 11Aa, in pressing contact with the electrode 1j and the connecting terminal pin 3b in the space portion 11Ab, in pressing contact with the electrode 1k and the connecting terminal pin 3c in the space portion for the connecting terminal pin 3c and in pressing contact with the electrode 1i and the connecting terminal pin 3d in the space portion for the connecting terminal pin 3d, whereby the connecting terminal pins 3a, 3b, 3c and 3d are electrically connected to the insulating substrate 1'.

Meanwhile, the coiled spring 10 best shown in Fig. 4(a) can be replaced by a V-shaped spring plate 14 shown in Fig. 4(b) or a V-shaped spring plate 15 having a projecting contact 15a formed on one side thereof by, for example, press working for engagement with each of the electrodes 1h, 1i, 1j and 1k. Since other constructions of the high-voltage variable resistor K are similar to those of the conventional high-voltage variable resistor shown in Figs. 1(a) to 1(d), description thereof is abbreviated for brevity.

Referring to Figs. 5(a) to 5(d), 6(a) and 6(b), there is shown a high-voltage variable resistor K' according to a second embodiment of the present invention.

The high-voltage variable resistor K' includes an insulating casing 6'' having a front face 6''A and a rear face 6''B and a coiled spring 16 having a ring portion 16a through which each of the connecting terminal pins 3a, 3b, 3c and 3d is inserted. As shown in Fig. 5(a), a groove 11Bb is formed in the space portion 11Ab on one face of a front wall 6''H opposite to the front face 6''A so as to receive a part of the ring portion 16a of the coiled spring 16. In the same manner as described above, three other grooves are, respectively, formed in the space portion 11Aa and the space portion for the connecting terminal 3c and the space portion for the connecting terminal pin 3d.

In the above described arrangements of the high-voltage variable resistor K', firstly the coiled springs 16 are, respectively, accommodated into the space portions 11Aa and 11Ab and the space portion for the connecting terminal pin 3c and the space portion for the connecting terminal pin 3d so that the ring portion 16a may be fitted into each of the groove for the connecting terminal pin 3a, groove 11Bb, groove for the connecting terminal pin 3c and groove for the connecting terminal pin 3d. Then, the connecting terminal pins 3a, 3b, 3c and 3d are, respectively, fitted into the through-opening extending concentrically with the insulating cover 7'a, through-opening 11b, through-opening extending concentrically with the insulating cover 7'c and through-opening for the connecting terminal pin 3d so as to extend through the ring portions 16a. It is to be noted that the groove for the connecting terminal pin 3a, groove 11Bb, groove for the

connecting terminal pin 3c and groove for the connecting terminal pin 3d are provided for positioning the ring portions 16a so as to facilitate insertion of the connecting terminal pins 3a, 3b, 3c and 3d into the ring portions 16a. Thus, when the connecting terminal pins 3a, 3b, 3c and 3d are inserted into the ring portions 16a, electrical connection between each of the connecting terminal pins 3a, 3b, 3c and 3d and the corresponding coiled spring 16 is secured and the coiled spring 16 is accurately positioned, thereby resulting in improvement of the working efficiency.

Meanwhile, the coiled spring 16 having the ring portion 16a can be replaced by a conical coiled spring 17 having a ring portion 17a shown in Fig. 5(d). Since one end of the conical coiled spring 17 remote from the ring portion 17a is made smaller, in diameter, than the ring portion 17a, the conical coiled spring 17 is less subjected to inclination during use thereof than the coiled spring 16, whereby, electrical connection between each of the connecting terminal pins 3a, 3b, 3c and 3d and the conical coiled spring 17 is made more stable.

Furthermore, it is to be noted that each of the connecting terminal pins 3a, 3b, 3c and 3d is formed with a flange 3f for allowing the connecting terminals 3a, 3b, 3c and 3d to extend over a predetermined distance into the space portions 11Aa and 11Ab, the space portion for the connecting terminal pin 3c and the space portion for the connecting terminal pin 3d, respectively and a knurled portion 3e for preventing the connecting terminals 3a, 3b, 3c and 3d from being withdrawn out of the through-openings 11a, 11b, 11c and 11d, respectively and from being rotated. However, as shown in Fig. 6(a), the connecting terminal pins 3a, 3b, 3c and 3d can be replaced by connecting terminal pins 3'a, 3'b, 3'c and 3'd having a flange 3'f, a short knurled portion 3'e and an engagement portion 3'g for engagement with the ring portion 16a of the coiled spring 16. Moreover, the connecting terminal pins 3a, 3b, and 3c and 3d can be replaced by connecting terminal pins 3''a, 3''b, 3''c and 3''d having a flange 3''f, a short knurled portion 3''e, an engagement portion 3''g for engagement with the ring portion 16a of the coiled spring 16 and a small diameter end 3''h remote from the engagement portion 3''g. It is to be noted that the short knurled portions 3'e and 3''e are reduced, in length, to the through-opening extending concentrically with the insulating cover 7'a, through-opening 11b, through-opening extending concentrically with the insulating cover 7'c and through-opening for the connecting terminal pin 3d while the engagement portions 3'g and 3''g have a diameter corresponding to that of the ring portion 16a of the coiled spring 16.

Since in the high-voltage variable resistors K and K', the connecting terminal pins 3a, 3b, 3c and 3d are substantially held by the insulating casings 6' and 6'', respectively, there is a possibility that, when the insulating casings 6' and 6'' are subjected to shrinkage or deformation by heating of the thermosetting resin 8 for curing thereof, the connecting terminal pins 3a, 3b, 3c and 3d are not positively held by the insulating casing 6' and 6'', respectively or a space 19A including regions of sliding movement of the sliding members 2a and 2b is deteriorated in heat resistance. Since other constructions of the high-voltage variable resistor K' are similar to those of the high-voltage variable resistor K, description thereof is abbreviated for brevity.

In order to eliminate such inconveniences as referred to above, there is shown in Figs. 7 and 8, a high-voltage variable resistor K'' according to a third embodiment of the present invention.

The high-voltage variable resistor K'' includes an insulating casing 6''' having a front face 6'''A and a rear face 6'''B, and an insulating substrate 1'' having a front face 1''A and a rear face 1''B. The insulating casing 6''' has space portions 19a, 19b, 19c and 19d each accommodating the coiled spring 10 therein, which are communicated with the through-opening extending concentrically with the insulating cover 7'a, through-opening 11b, through-opening extending concentrically with the insulating cover 7'c and through-opening for the connecting terminal pin 3d, respectively. The insulating casing 6''' has, further, recess portions 18a, 18b, 18c and 18d which are, respectively, formed in the course of the through-opening extending concentrically with the insulating cover 7'a, through-opening 11b, through-opening extending concentrically with the insulating cover 7'c and through-opening for the connecting terminal pin 3d so as to be communicated with the through-opening extending concentrically with the insulating cover 7'a, through-opening 11b, through-opening extending concentrically with the insulating cover 7'c and through-opening for the connecting terminal pin 3d. The thermosetting resin 8 is injected not only onto the rear face 1''B of the insulating substrate 1'' but into the recess portions 18a, 18b, 18c and 18d, whereby the insulating substrate 1'' is more positively held by the thermosetting resin 8 while the space 19A including regions of sliding movement of the sliding members 2a and 2b and the space portions 19a, 19b, 19c and 19d are more securely electrically insulating and shielded against atmosphere outside the insulating casing 6'''. At the same time, since a part of each of the connecting terminal pins 3a, 3b, 3c and 3d extending through the recess portions 18a, 18b, 18c and 18d, respectively, is molded by the thermosetting resin 8, the connecting terminal pins 3a, 3b, 3c and 3d are not only directly held by the insulating casing 6''' but fixed in position by the thermosetting resin 8. Since other constructions of the high-voltage variable resistor K'' are similar to those of the high-voltage variable resistor K, description thereof is abbreviated for brevity.

Furthermore, referring to Figs. 9 to 13, there is shown a high-voltage variable resistor K''' according to a fourth embodiment of the present invention.

The high-voltage variable resistor K''' includes an insulating casing 6'''' having a front face 6''''A and a rear face 6''''B, and an insulating substrate 1''' having a front face 1'''A and a rear face 1'''B. Although the thermosetting resin 8 is applied to the whole surface of each of the rear faces 1'B, 1'B and 1'''B of the insulating substrate 1', 1', and 1''' in the high-voltage variable resistors K, K' and K'', respectively, the

thermosetting resin 8 is applied only to the periphery of the insulating substrate 1''' in the high-voltage variable resistor K''' so that almost all the rear face 1'''B may be exposed to atmosphere as best shown in Figs. 9 and 10. Since the insulating substrates 1', 1'' and 1''' made of alumina, etc. are far greater, in thermal conductivity, than the thermosetting resin 8 such as epoxy resin, etc., the thermosetting resin 8 is provided only at the periphery of the insulating substrate 1''' in order to radiate heat produced at a resistor portion (not shown) of the insulating substrate 1''' out of the insulating casing 6'''' rapidly. Meanwhile, although the insulating substrates 1', 1'' and 1''' are superior, in voltage resistance, water absorbing capacity and heat resistance, to the thermosetting resin 8, the above described excellent properties of the insulating substrates 1', 1'' and 1''' are not fully utilized in the high-voltage variable resistors K, K' and K'', respectively. It should be noted here that since the thermosetting resin 8 is used mainly for electrically insulating the insulating substrates 1', 1'' and 1''', provision of the thermosetting resin 8 only at the periphery of the rear face 1'''B is sufficient therefor. Thus, the excellent properties of the insulating substrate 1''' can be utilized to full extent.

Hereinbelow, a method of injecting the thermosetting resin 8 at the periphery of the insulating substrate 1''' and a structure of the insulating casing 6'''' suited therefor will be described with reference to Figs. 11 to 13. When the insulating substrate 1''' is placed on a bearing face 6''''C with the connecting terminal pins 3a, 3b, 3c and 3d being electrically connected to the insulating substrate 1''' through the coiled springs 10, respectively, a proper amount of the thermosetting resin 8 is dropped at a plurality of locations along the periphery of the insulating substrate by using a nozzle 20 as shown in Fig. 11. Then, the dropped thermosetting resin 8 is heated for curing. The thermosetting resin 8 is lowered, in viscosity, temporarily by heating of the thermosetting resin 8 so as to spread between the insulating casing 6'''' and the insulating substrate 1''', whereby the dropped thermosetting resin 8 is linked with one another so as to seal the periphery of the insulating substrate 1'''. It is to be noted that the nozzle 20 is required to be spaced a slight distance from the inner peripheries of rear wall portions 6''''Db, 6''''Fb and 6''''Gb of an upper side wall 6''''D, a left side wall 6''''F and a right side wall 6''''G, and of a rear wall portion of a lower side wall 6''''E, respectively. For example, if peripheral edges of the insulating substrate 1''' is disposed excessively adjacent to the inner peripheries of the rear wall portions 6''''Db, 6''''Fb and 6''''Gb, and of the rear wall portion of the lower side wall 6''''E and peripheral edges of the insulating substrate 1''' are improperly sealed by the thermosetting resin 8 in case of a slight displacement of the nozzle 20 from its predetermined position when a small amount of the thermosetting resin 8 is dropped thereon. Meanwhile, in the case where the peripheral edges of the insulating substrate 1''' are displaced a rather large distance from the inner peripheries of the rear wall portions 6''''Db, 6''''Fb and 6''''Gb and of the rear wall portion of the lower side wall 6''''E so as to eliminate improper sealed portions, the thermosetting resin 8 tends to spread only into a clearance between the insulating substrate 1''' and the bearing face 6''''C, thus resulting in improper sealing of the insulating substrate 1''' as shown in Fig. 12. Accordingly, in order to eliminate the above described disadvantage, the insulating casing 6'''' further has a tapered portion 21G (Fig. 13) formed on the inner periphery of the rear wall portion 6''''Gb. In the same manner as described above, the rear wall portions 6''''Db and 6''''Fb and the rear wall portion of the lower side wall 6''''E are formed with tapered portions, respectively, so that adhesion area of the thermosetting resin 8 is enlarged and improper sealing of the insulating substrate 1''' is eliminated. Since other constructions of the high-voltage variable resistor K''' are similar to those of the high-voltage variable resistor K, description thereof is abbreviated for brevity.

In accordance with the present invention, since the connecting terminal pins are disposed in parallel with the opposite surfaces of the insulating substrate and are electrically connected to the insulating substrate through the springs, it becomes unnecessary to perform the hitherto required soldering process and flux washing process. Meanwhile, even if an external force is applied to the connecting terminal pins, the springs act as shock absorbers so that damage to the insulating substrate or improper electrical connection between the insulating substrate and the connecting terminal pins may be eliminated, whereby working efficiency and reliability of the high-voltage variable resistor have been remarkably improved.

Meanwhile, in accordance with the present invention, since the coiled spring is provided with the ring portion through which the connecting terminal pin is inserted, and a groove is formed on the front wall of the insulating casing defining the bottom of the space portion for accommodating the coiled spring therein so that a part of the ring portion may be fitted into the groove, electrical connection between the connecting terminal pins and the insulating substrate is more positively secured and the coiled spring can be brought into engagement with the connecting terminal pin more easily.

Furthermore, in accordance with the present invention, since a recess portion is provided in the course of the through-opening of the connecting terminal pin so as to be communicated with the through-opening and a part of the connecting terminal pin extending through the recess portion is molded by the thermosetting resin, the connecting terminal pins are securely held by the insulating casing even if the insulating casing is subjected to deformation by heating of the thermosetting resin for curing thereof and thus, reliability of the high-voltage variable resistor has been remarkably improved. Meanwhile, the space including regions of sliding movement of the sliding members are sufficiently shielded against atmosphere outside the insulating casing and therefore, is improved in humidity resistance.

Moreover, in accordance with the present invention, since the thermosetting resin is applied only to the periphery of the insulating substrate, heat produced at the resistor portion of the insulating substrate is

rapidly radiated out of the insulating casing and the high-voltage variable resistor is prevented from being adversely affected by heat. Meanwhile, since the insulating substrate can be made smaller in size, the high-voltage variable resistor can be made compact in size and light in weight.

5 Claims

1. A high voltage variable resistor comprising a platelike insulating substrate (1) provided with a resistor portion having at least one circular portion (1a, 1b) with said resistor portion being formed on one of the major surfaces of said substrate by printing, a sliding member (2a) provided so as to confront said one of said major surfaces of said substrate and to be rotated in sliding contact with said circular portion of said resistor portion of said substrate, a plurality of connecting terminals (3a—d) connected to said resistor portion and said sliding member, a rotational rod (4) coupled with said sliding member so as to rotate said sliding member, and a casing (6) for accommodating said substrate and said sliding member therein, with a part of said rotational rod projecting out of said casing, characterized in that said connecting terminals (3a—d) are disposed in parallel with said major surfaces (1'A) of said substrate, each of said connecting terminals (3a—d) having a contact portion extending in parallel with said major surfaces of the substrate, that a plurality of space portions (11A), each surrounded by an insulating wall, are formed in said casing, that spring means (10) are, respectively, accommodated in said space portions (11Aa, 11Ab) and that an urging force of said spring means (10) is directed at right angles to said major surfaces of said substrate (1), and that said connecting terminals (3a—d) extend, respectively, through said casing (6) into said space portions (11Aa, 11Ab) such that each of said connector portions (1h—k) of said resistor portion and each of said contact portions of said connecting terminals (3a—d) are connected to each other in each of said space portions (11Aa, 11Ab) by each of said spring means (10).

2. A high-voltage variable resistor as claimed in Claim 1, wherein said spring means are coiled springs (10).

3. A high-voltage variable resistor as claimed in Claim 2, wherein each of said coiled springs has a ring portion (16a, 17a) through which each of said connecting terminals (3e) is inserted, said casing (6) having a plurality of grooves (11Bb) formed on wall portions thereof defining said space portions (11A) so that a part of each of said ring portions may be fitted into each of said grooves.

4. A high-voltage variable resistor as claimed in Claim 1, wherein said spring means are V-shaped spring plate (14, 15).

5. A high-voltage variable resistor as claimed in Claim 4, wherein each of said V-shaped spring plate has a projecting contact (15a) formed on one side thereof for engagement with each of said electrodes of said substrate.

6. A high-voltage variable resistor as claimed in Claim 1, wherein said connecting terminals, respectively, extends through a plurality of through-openings (11b) formed on said casing, a predetermined space (19A) in said casing, for regions of sliding movement of said sliding members being molded by resin, a plurality of recess portions (18) being, respectively, formed in the course of said through-openings (11b) so as to be communicated with said through-openings, said resin being also applied to said recess portions so as to hold a part of each of said connecting terminals extending through said recess portions.

7. A high-voltage variable resistor as claimed in Claim 1, wherein resin (8) is applied to a periphery of said substrate accommodated in said casing so as to seal said periphery of said substrate.

8. A high voltage variable resistor as claimed in Claim 7, wherein wall portions adjoining a bearing face for supporting said substrate is, respectively, formed with tapered portions (21G) in said casing.

Patentansprüche

1. Variabler Hochspannungswiderstand mit einem plattenförmigen Isolatorsubstrat (1), welches einen Widerstandsteil aufweist, welches mindestens einen kreisförmigen Teil (1a, 1b) aufweist, wobei das Widerstandsteil auf der Hauptfläche des Substrats durch Drucken aufgebracht ist, mit einem Gleitelement (2a), welches so vorgesehen ist, daß es einer der Hauptflächen des Substrats gegenüberliegt und in Gleitkontakt mit dem kreisförmigen Teil des Widerstandsteils des Substrats gedreht werden kann, mit einer Vielzahl von Verbindungsanschlüssen (3a—d), die mit dem Widerstandsteil und dem Gleitelement verbunden sind, mit einem Drehstab (4), der mit dem Gleitelement so verbunden ist, daß er das Gleitelement drehen kann, und mit einem Gehäuse (6) zum Unterbringen des Substrats und des Gleitelements darin, wobei ein Teil des Drehstabes aus dem Gehäuse herausragt, dadurch gekennzeichnet, daß die Verbindungsanschlüsse (3a—d) parallel zur Hauptfläche (1'A) des Substrats angeordnet sind, daß jedes der Anschlußelemente (3a—d) einen Kontaktteil aufweist, der sich parallel zur Hauptfläche des Substrats erstreckt, daß eine Vielzahl von Freiräumen (11A), die jeweils von einer Isolierwand umgeben sind, im Gehäuse ausgebildet sind, daß Federelemente (10) jeweils in den Freiräumen (11Aa, 11Ab) untergebracht sind und daß die Druckkraft der Federelemente (10) rechtwinklig zur Hauptfläche des Substrats (1) ausgerichtet ist, und daß die Verbindungsanschlüsse (3a—d) sich jeweils durch das Gehäuse (6) in die Freiräume (11Aa, 11Ab) so erstrecken, daß jedes der Verbindungsteile (1h—k) des

Widerstandsteils und der jeweilige Kontaktteil des Verbindungsanschlusses (3a—d) jeweils in dem Freiraum (11Aa, 11Ab) durch das jeweilige Federelement (10) miteinander verbunden sind.

2. Variabler Hochspannungswiderstand nach Anspruch 1, dadurch gekennzeichnet, daß die Federelemente Spiralfedern (10) sind.

5 3. Variabler Hochspannungswiderstand nach Anspruch 2, dadurch gekennzeichnet, daß jede der Spiralfedern einen Ringteil (16a, 17a) aufweist, durch welchen der jeweilige Verbindungsanschluß (3e) eingeführt ist und daß das Gehäuse (6) eine Vielzahl von Nuten (11Bb) aufweist, die auf seinen Wandteilen ausgeformt sind und die Freiräume (11A) bilden, so daß ein Teil des jeweiligen Ringteils in die Nuten eingepaßt werden kann.

10 4. Variabler Hochspannungswiderstand nach Anspruch 1, dadurch gekennzeichnet, daß die Federelemente V-förmige Federplatten (14, 15) sind.

5. Variabler Hochspannungswiderstand nach Anspruch 4, dadurch gekennzeichnet, daß jede der V-förmigen Federplatten einen vorspringenden Kontakt (15a) aufweist, der auf einer seiner Seiten ausgebildet ist, um im Eingriff mit den Elektroden des Substrats zu stehen.

15 6. Variabler Hochspannungswiderstand nach Anspruch 1, dadurch gekennzeichnet, daß die Verbindungsanschlüsse jeweils sich durch eine Vielzahl von Durchgangsöffnungen (11b) im Gehäuse erstrecken, daß ein vorbestimmter Freiraum (19A) im Gehäuse für die Bereiche der Gleitbewegung der Gleitelemente aus Harz gegossen ist und daß eine Vielzahl von Ausnehmungsbereichen (18) jeweils im Bereich der Durchgangsöffnungen (11b) ausgebildet ist, um mit den Durchgangsöffnungen zu kommunizieren, wobei das Harz auch in den Ausnehmungsbereichen angebracht wird, um einen Teil der Verbindungsanschlüsse zu halten, die sich durch die Ausnehmungsbereiche erstrecken.

20 7. Variabler Hochspannungswiderstand nach Anspruch 1, dadurch gekennzeichnet, daß Harz (8) an der Peripherie des Substrats aufgebracht ist, welches im Gehäuse untergebracht ist, um die Peripherie des Substrats abzudichten.

25 8. Variabler Hochspannungswiderstand nach Anspruch 7, dadurch gekennzeichnet, daß die Wandteile im Gehäuse, die an der Tragefläche zum Abstützen des Substrats anliegen, jeweils mit geneigten Teilen (21G) ausgebildet sind.

Revendications

30 1. Résistance variable pour haute tension, comprenant: un substrat isolant du genre plaque (1) pourvu d'une partie résistance ayant au moins une partie circulaire (1a, 1b), ladite partie résistance étant formée par impression sur la première des grandes surfaces dudit substrat; un organe glissant (2a) agencé de manière à être en vis-à-vis de ladite première grande surface dudit substrat et à pouvoir tourner en contact
35 glissant avec ladite partie circulaire de ladite partie résistance dudit substrat; une pluralité de bornes de connexion (3a—d) connectées à ladite partie résistance et audit organe glissant; une tige tournante (4) couplée audit organe glissant de manière à le faire tourner; et un boîtier (6) pour recevoir ledit substrat et ledit organe glissant, une partie de ladite tige tournante débordant à l'extérieur dudit boîtier, caractérisée en ce que lesdites bornes de connexion, (3a—d) sont disposées parallèlement auxdites grandes surfaces
40 (1'A) dudit substrat, chacune desdites bornes de connexion (3a—d) ayant une partie contact qui s'étend parallèlement auxdites grandes surfaces du substrat, en ce que plusieurs portions d'espace (11A), entourées chacune par une paroi isolante, sont formées dans ledit boîtier, en ce que des moyens élastiques (10) sont respectivement reçus dans lesdites portions d'espace (11Aa, 11Ab) et en ce qu'une force de sollicitation desdits moyens élastiques (10) est dirigée à angle droit par rapport auxdites grandes surfaces
45 dudit substrat (1), et en ce que lesdites bornes de connexion (3a—d) s'étendent respectivement au travers dudit boîtier (6) dans lesdites portions d'espace (11Aa, 11Ab), de manière que chacune desdites portions de connecteur (1h—k) de ladite partie résistance, et chacune desdites parties contact desdites bornes de connexion (3a—d) soient mutuellement connectées dans chacune desdites portions d'espace (11Aa, 11Ab), par chacun desdits moyens élastiques (10).

50 2. Résistance variable pour haute tension selon revendication 1, dans laquelle lesdits moyens élastiques sont des ressorts enroulés (10).

3. Résistance variable pour haute tension selon revendication 2, dans laquelle chacun desdits ressorts enroulés possède une partie annulaire (16a, 17a) dans laquelle chacune desdites bornes de connexion (3e) est insérée, ledit boîtier (6) ayant plusieurs rainures (11Bb) formées sur des parties paroi de celui-ci,
55 définissant lesdites portions d'espace (11A), de manière qu'une partie de chacune desdites parties annulaires puisse être adaptée dans chacune desdites rainures.

4. Résistance variable pour haute tension selon revendication 1, dans laquelle lesdits moyens élastiques sont des lames élastiques façonnées en forme de V (14, 15).

5. Résistance variable pour haute tension selon revendication 4, dans laquelle chacune des lames
60 élastiques façonnées en forme de V possède un contact saillant (15a) formé sur l'un de ses côtés, destiné à venir en condition d'engagement avec chacune desdites électrodes dudit substrat.

6. Résistance variable pour haute tension selon revendication 1, dans laquelle lesdites bornes de connexion s'étendent respectivement au travers d'une pluralité d'ouvertures traversantes (11b) formées sur ledit boîtier, d'un espace prédéterminé (19A) dans ledit boîtier, pour des zones de glissement desdits
65 organes de glissement, moulées par résine, de plusieurs parties évidées (18) qui sont respectivement

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formées sur le trajet desdites ouvertures traversantes (11b) de façon à être en communication avec celles-ci, de ladite résine qui est aussi appliquée auxdites parties évidées de manière à maintenir une partie desdites bornes de connexion qui s'étendent au travers desdites parties évidées.

7. Résistance variable pour haute tension selon revendication 1, dans laquelle de la résine (8) est appliquée à une périphérie dudit substrat reçue dans ledit boîtier, de manière à sceller ladite périphérie dudit substrat.

8. Résistance variable pour haute tension selon revendication 7, dans laquelle des parties du paroi attenantes à une face-support destinée à supporter ledit substrat sont respectivement dotées de portions chanfreinées (21G), dans ledit boîtier.

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Fig. 1(a) PRIOR ART

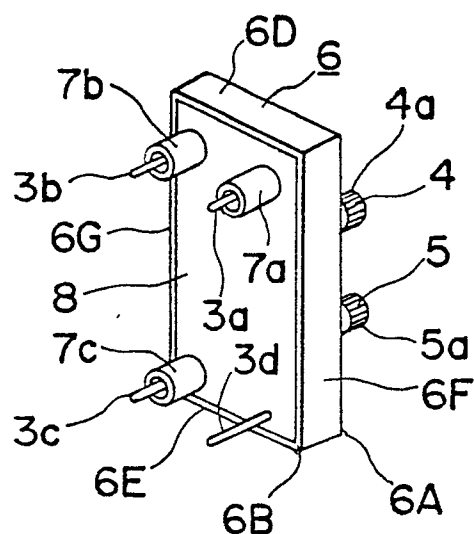


Fig. 1(b) PRIOR ART

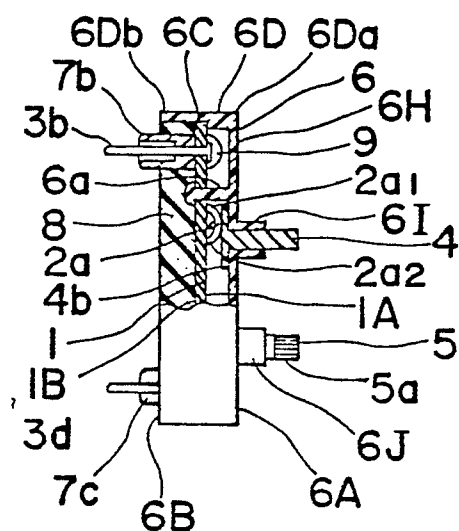


Fig. 1(c) PRIOR ART

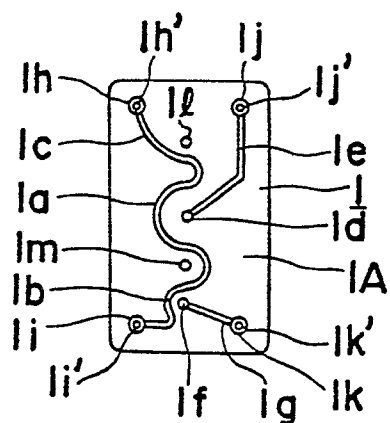


Fig. 1 (d) PRIOR ART

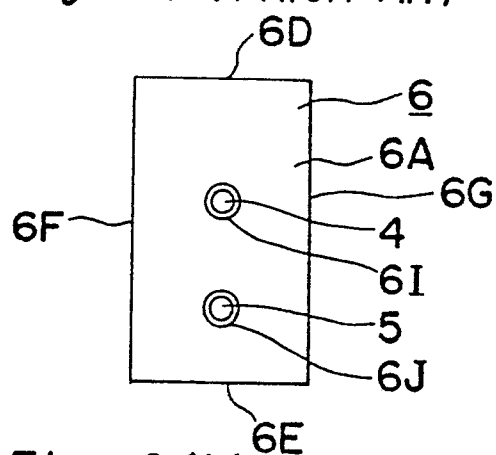


Fig. 2(a)

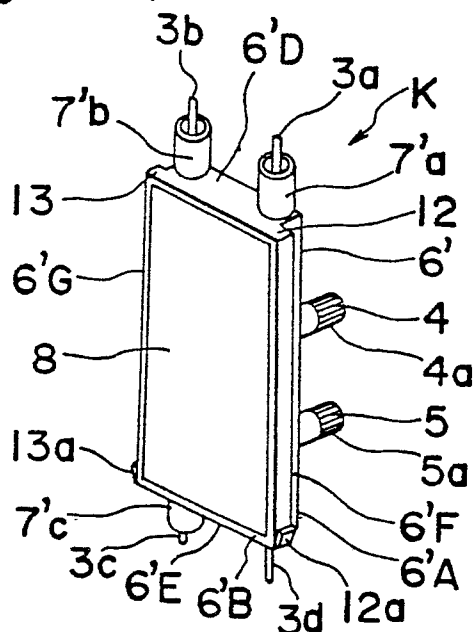


Fig. 2 (b)

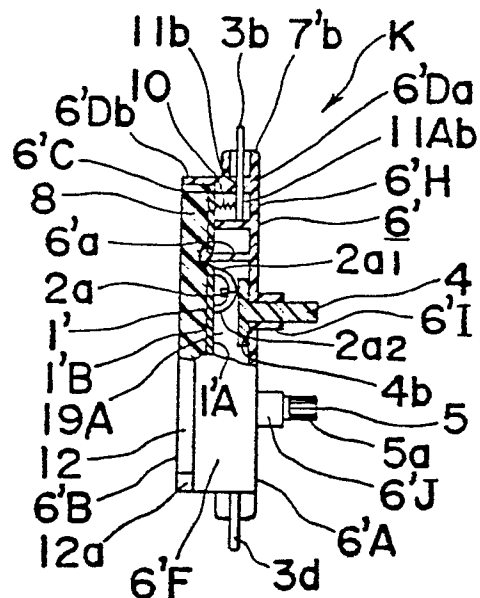


Fig. 9

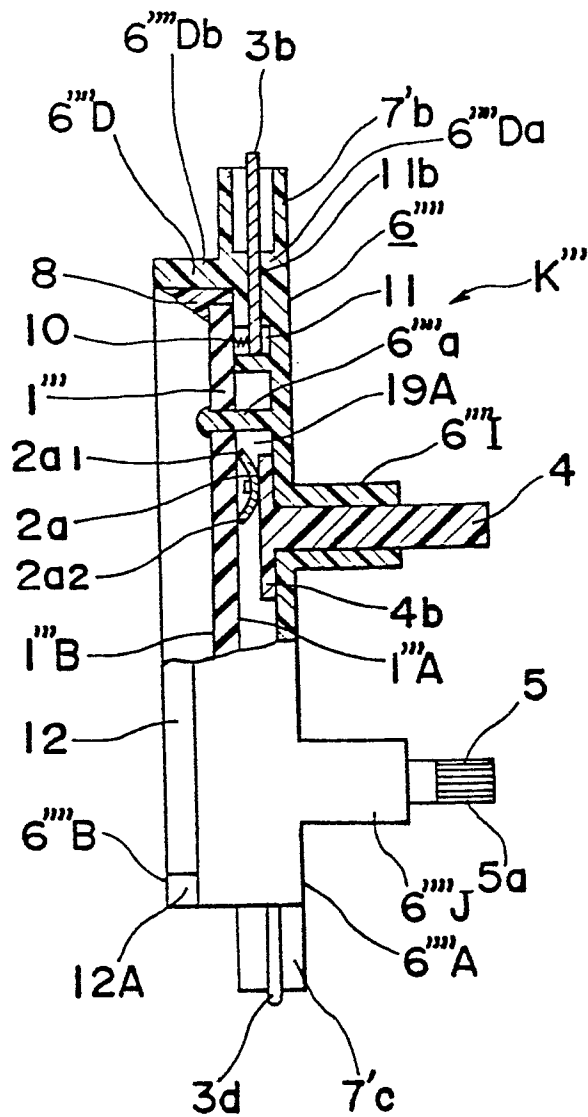


Fig. 10

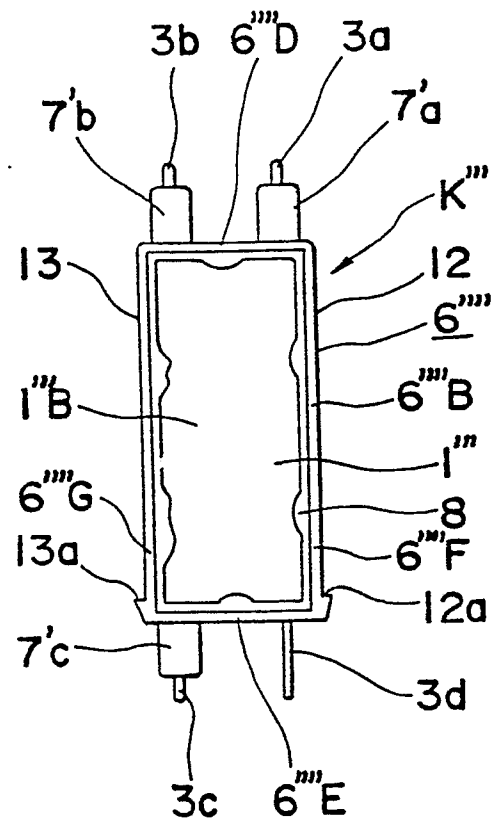


Fig. 2(c)

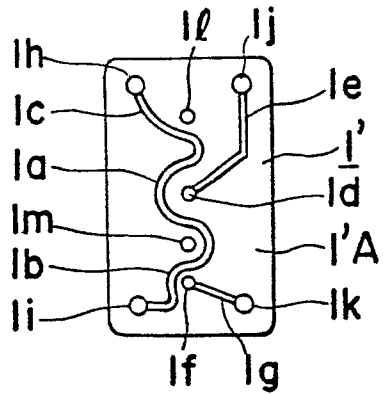


Fig. 3

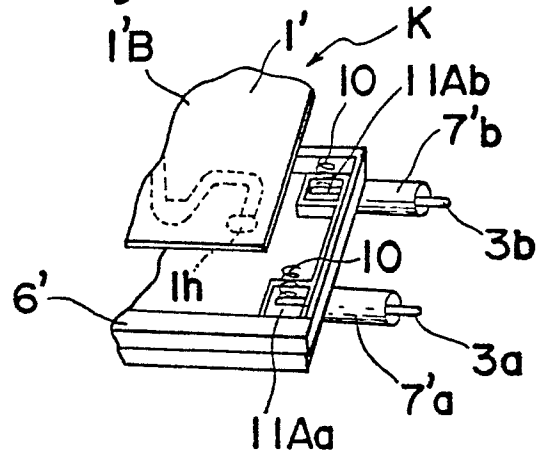


Fig. 4(a)

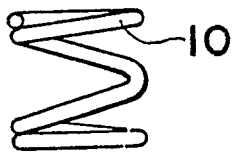


Fig. 4(b)

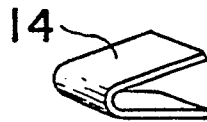


Fig. 4(c)

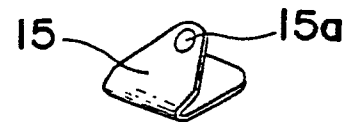


Fig. 5(a)

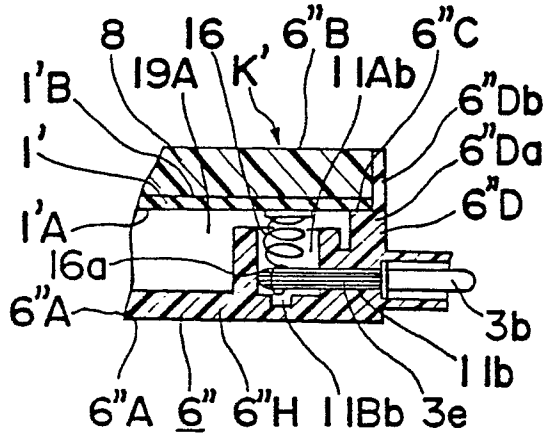


Fig. 5(b)

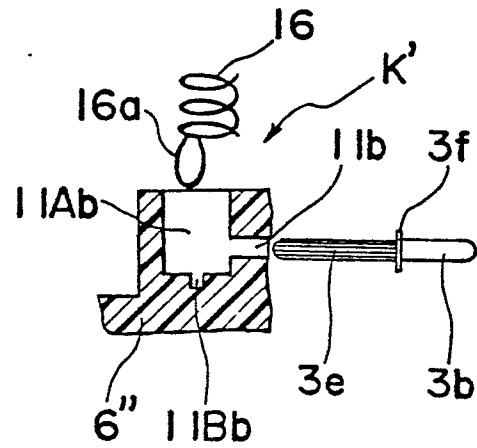


Fig. 5(c)

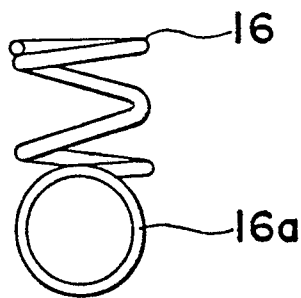


Fig. 5(d)

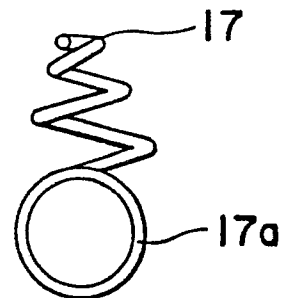


Fig. 11

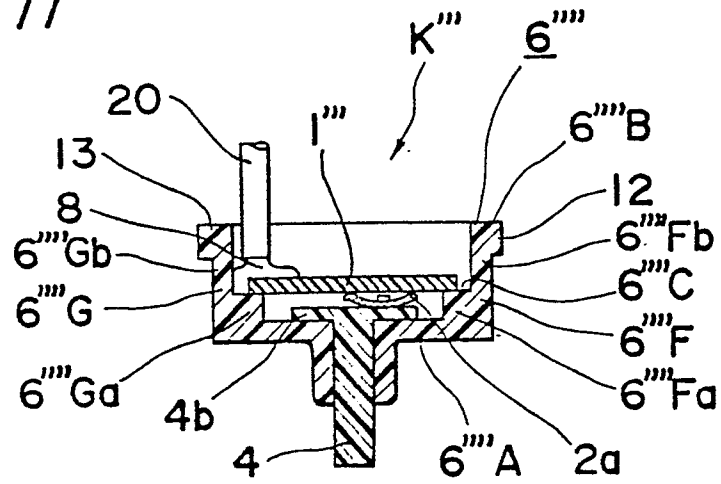


Fig. 12

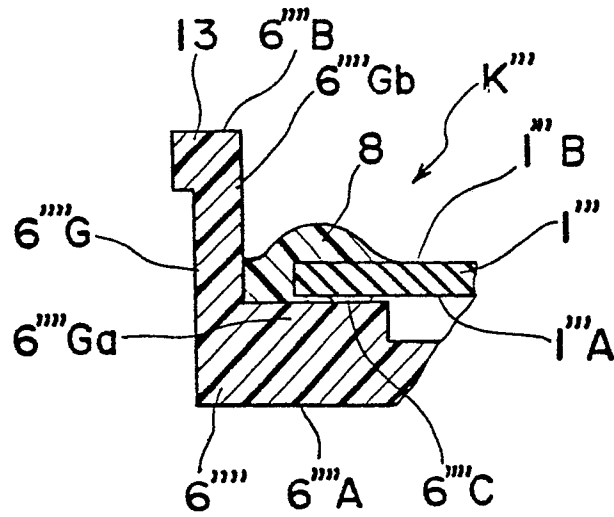


Fig. 13

